



Motivations for Healthy Eating Decreased after the COVID-19 Pandemic in the Daqing Area of China

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Abstract

This study examined whether the perceptions of the theory of planned behavior (TPB) and individual and environmental factors related to healthy eating changed after the COVID-19 pandemic among adults living in Daqing, China. Data were collected through two rounds of online surveys conducted from April to May 2021 and from March to April 2023, using a questionnaire previously validated for use in Daqing. Using the snowball sampling method, 571 adult participants were recruited, most of whom were Daqing oilfield workers or members of their families. Multiple linear regression analyses were used to determine if the differences in the perceptions of the TPB and dietary environments exist during and after the pandemic after controlling for potential confounders. Scores of several subcomponents of TPB and mean scores of long-term intentions increased but scores of subcomponents and overall mean of motivation decreased after the outbreak. Multiple linear regression showed that only motivation for healthy eating decreased after the pandemic. Influenced by the pandemic, people increased their healthy eating behaviors. Nevertheless, as the pandemic subsided and the pace of life accelerated, people tended to choose convenient foods over healthy options. Consequently, the motivation for healthy eating has declined post-pandemic compared to during the pandemic.

Key Words : China, diet, motivation, COVID-19

1. Introduction

The human-to-human transmission characteristics of the SARS-CoV-2 virus, which causes COVID-19 (Yuki et al. 2020), led to a global pandemic that forced countries to implement emergency measures, such as social distancing and lockdowns, in response to this sudden public health crisis (Abid et al. 2020; Ceylan et al. 2023). Due to of the pandemic, consumption patterns and daily habits changed significantly. This period was characterized by an increase in purchases of cleaning products and an increased engagement in activities such as cooking, housework, use of social media, fitness, and online shopping. Unhealthy diets and junk food consumption significantly increased for some individuals during the isolation periods of the pandemic (Yau & Potenza 2013). This is expected as supply chain access to fresh fruits and vegetables was often limited during lockdowns, which may have led to dietary imbalances. Studies have shown that a balanced diet plays an important role in maintaining immune response (John et al. 2009); therefore, maintaining a balanced diet was especially important during the pandemic.

This study focuses on Daqing, China. Unlike the southern cities in China, the northern cities, such as Daqing, typically have ample stores of meat but lack availability of green vegetables. During the isolation period, this led to an unbalanced diet among most residents, even resulting in obesity issues. The Daqing city government initiated vigorous measures to address the lack of availability of vegetables in diets during the pandemic by providing free vegetable packages, the first of which was provided at 7:00 p.m. on August 31, 2022. These packages were transported and arrived promptly in Daqing (Daqing Official website 2022). Daqing implemented a home quarantine system after it was announced that quarantine would be required during the pandemic. The government enacted the uniform distribution of free vegetable packages, which were managed by the Pandemic Control Command Center and provided on a per-household basis. For example, the free vegetable packages provided on September 4, 2022 (Yusi 2022), weighed 20 pounds each and contained nine types of vegetables, including potatoes, onions, cabbages, bok choys, cucumbers, chili peppers, scallions, gingers, and garlics. This initiative aimed to ensure

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that the public had sufficient access to vegetables during the pandemic, so as to encourage them to maintain a balanced diet and improve overall nutrition. Through the provision of these packages, the government provided a positive response to the specific needs faced by the population during the pandemic and helped restructure people's diets to provide a more balanced choice of food, thereby promoting overall health.

This study builds upon three previous surveys conducted by our research group to provide a more extensive examination of the healthy eating habits of adults in Daqing, China. In our previous studies, we covered Beijing (Liu et al. 2021), Shanghai, parts of the Anhui province (Liu et al. 2022), and Daqing (Ma et al. 2023). The results of this series of studies, examined using the theory of planned behavior (TPB), consistently indicate that perceived behavioral control (PBC) had the most significant influence on healthy eating behaviors. However, it is difficult to understand the general characteristics situation of a city or a region from a study conducted at a single point in time. Therefore, this study uses a mid-point and the aftermath of the COVID-19 pandemic as a pair of time points to establish whether the diets of adults in Daqing underwent significant changes in terms of health-promoting diets during and after the pandemic. This study aimed to more comprehensively grasp the evolution of lifestyle and behavioral habits triggered by the pandemic by comparing the same region at different time points.

II. Materials and Methods

1. Research hypothesis

First, attitudes, subjective norms, PBC, short-term behavioral intentions, and long-term behavioral intentions among adults in Daqing changed between during and after the COVID-19 pandemic. Second, perceptions of healthy eating-out options (food attributes and food quality), social support, healthy eating awareness, and motivation (importance and agreement) among adults in Daqing also changed between during and after the pandemic.

2. Ethics statement

Written informed consent was obtained from each participant. This study received approval from the Institutional Review Board of Sangmyung University in October 2020 (approval number: SMUIRBC-2020-009, SMUIRBC-2023-001).

3. Sample population

The subjects of this study included adults residing in Daqing China who were of the same demographic characteristics as the sample population in our previous studies, primarily comprising Daqing oilfield workers and their family members (Ma et al. 2023). Two rounds of surveys were conducted from April to May 2021 and from March to April 2023, with a total of 577 participants responding proactively to the questionnaire, who received an incentive for doing so. We used a targeted snowball sampling method and collected data through online channels. Specifically, WeChat was used as the primary channel through which responses were collected via scanning QR codes or clicking links. After six subjects who provided incomplete information were excluded, the final number of subjects eligible for analysis was 571.

4. Study questionnaire

The development of the questionnaire used in this study has been thoroughly described in our previous studies (Liu et al. 2021; Liu et al. 2022; Ma et al. 2023). The final version of the questionnaire was established following a preliminary survey among international students majoring in nutrition in China, using a Chinese version of a questionnaire translated by an expert for use on Chinese adults. It is important to note that to ensure the validity and applicability of the questionnaire, we used a version of the questionnaire that was previously validated for adolescents (Özenoğlu 2021; Yaseen 2021). Among Chinese adults, we observed that the study questionnaire had high explanatory power, recorded at 76.6% (Liu et al. 2021), 70.5% (Liu et al. 2022), and 83.6% (Ma et al. 2023). This finding provided a solid foundation for subsequent data collection and analysis.

Data on the age, sex, height, and weight of each participant were collected, and their body mass index (BMI) were calculated and categorized into the following ranges: <18.5, 18.5-22.9, 23.0-24.9, and 25.0-29.9 kg/m². Current alcohol drinkers, Current smokers, and Having disease were all categorized into two groups each in terms of having experienced the factor or not. Marital status was also categorized into two groups: married and single/divorced. Educational background was categorized by those who had achieved a bachelor's degree or above and those who had not. Subjects were categorized by whether they were employed.

Our previous studies describe the three dimensions of the TPB (attitude, subjective norms, and PBC) and long- and short-term behavioral intentions to engage in healthy eating habits (Wu et al. 2009; Grønhøj et al. 2012). The Cronbach's α coefficient was measured to identify the internal consistency for each dimension in our questionnaire, with the results as follows: attitude, 0.90 (six questions); subjective norms, 0.951 (eight questions); PBC, 0.913 (four questions); short-term behavioral intention toward healthy eating, 0.948 (four questions); and long-term behavioral intention toward healthy eating, 0.900 (five questions).

The individual and environmental factors related to healthy eating comprised six dimensions, including three used in the previous studies conducted by our group: social support (Dewar et al. 2012), food quality (Namkung & Jang 2008; Kwun 2011), and food attributes (Stephens et al. 1995; Namkung & Jang 2008; Kwun 2011). The Cronbach's α coefficient was also measured to verify internal consistency, the results were as follows: healthy eating-out options, food attribute, 0.936 (seven questions); healthy eating-out options, food quality, 0.956 (six questions); and social support, 0.864 (five questions). Motivation (importance, agreement) was assessed by asking respondents to rate their responses to questions on a 4-point Likert scale (1=absolutely disagree, 4=absolutely agree) and 6-point Likert scale (1=absolutely disagree, 6=absolutely agree) (Achtziger et al. 2008; Jun et al. 2014; Lee et al. 2020; De Kervenoae et al. 2021). The five questions were as follows: "A healthy eating can reduce some diseases or disorders."; "A healthy eating can make your mood happier through your body."; "A healthy eating can help to regulate weight."; "A healthy eating can help improve concentration."; and "A healthy eating can energize every day.". The Cronbach's α coefficient for the five questions was 0.928 and 0.957, respectively. Healthy eating awareness was assessed by asking respondents to rate their responses to questions on a 10-point Likert scale (1=absolutely disagree, 10=absolutely agree) (Dutta & Youn 1999; Garcia & Mann 2003; Hansen & Thomsen 2018; Azzurra et al. 2019). This section contained the following six questions: "How important is healthy eating to your life?" "How confident are you about conducting a healthy eating life?" "How well prepared are you for conducting a healthy eating life?" "How important is healthy food preparation to you?" "How confident are you in preparing healthy food?" and "How prepared are you for healthy cooking?" The Cronbach's α coefficient for these six items was 0.910.

5. Statistical analysis

Continuous data are described by means and standard deviations and categorical data as numbers and percentages. A t-test and a multiple linear regression analysis were employed to establish the relation between the COVID-19 pandemic and the five dimensions of the TPB and the six dimensions of the individual and environmental factors related to healthy eating for adults from Daqing during and after the COVID-19 pandemic. The results were adjusted for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment. The statistical analyses were performed using SPSS software (Statistical Package for the Social Sciences, version 21.0; IBM, Armonk, NY, USA). The statistical significance was set to $p < 0.05$.

III. Results and Discussion

1. General characteristics of the study subjects and analysis

Of the 571 subjects, 266 (46.6%) were males, with an average age of 35.64 ± 13.3 years <Table 1>. In this sample of 571, 64.4% had current alcohol drinkers, 35.0% had current smokers, 21.1% had having disease, 56.6% were married, 65.3% had a bachelor degree or above, and 62.3% had employed. The subjects were divided into two groups. The first group included 305 subjects surveyed during the COVID-19 pandemic, of whom 145 (47.5%) were males, with an average age of 32.3 ± 11.8 years. Among the subjects of the first group, 67.5% were current alcohol drinkers, 34.1% were current smokers, 16.1% had having disease, 44.6% were married, 77.0% had a bachelor degree or above, and 69.2% were employed. The second group included 266 subjects surveyed at the after of the COVID-19 pandemic, of whom 145 were males (45.5%), with an average age of 39.5 ± 13.9 years. In the second group, 60.9% were current alcohol drinkers, 36.1% were current smokers, 27.1% had having disease, 70.3% were married, 51.9% had a bachelor degree or above, and 54.5% were employed. Analysis showed significant differences in age ($p < 0.001$), having disease ($p = 0.001$), marital status ($p < 0.001$), education ($p < 0.001$), and employment ($p < 0.001$) between the two groups.

2. Scores of components of theory of planned behavior during and after COVID-19

The total mean scores for attitude ranged from 4.03 ("A healthy diet is generally desirable.") to 4.13 ("A healthy diet

<Table 1> General characteristics of the subjects

Variables	Total		During COVID-19		After COVID-19		t/x ²	P-values
	n	Mean±SD or %	n	Mean±SD or %	n	Mean±SD or %		
Male	266	46.6	145	47.5	121	45.5	0.240	0.624
Age (years)	571	35.6±13.3	305	32.3±11.8	266	39.5±13.9	-6.642	<0.001
Body mass index (kg/m ²)								
<18.5	72	12.6	37	12.2	35	13.2	0.343	0.952
18.5-22.99	243	42.6	130	42.6	131	42.8		
23-24.99	109	19.1	57	18.7	52	19.5		
≥25	147	25.7	81	26.6	66	24.8		
Current alcohol drinkers	368	64.4	206	67.5	162	60.9	2.733	0.098
Current smokers	200	35.0	104	34.1	96	36.1	0.248	0.619
Having disease	121	21.1	49	16.1	72	27.1	10.298	0.001
Married	323	56.6	136	44.6	187	70.3	38.229	<0.001
Bachelor degree or above	373	65.3	235	77.0	138	51.9	39.737	<0.001
Employed	356	62.3	211	69.2	145	54.5	13.024	<0.001

is generally beneficial.”), with an overall mean of 4.08 <Table 2>. The mean scores regarding subjective norms ranged from 3.92 (“Internet information think I should engage in healthy eating.”) to 4.06 (“Family members think I should engage in healthy eating.”), with an overall mean of 3.97. The mean PBC scores ranged from 3.82 (“Do you have enough time to eat healthily?”) to 4.05 (“Will you try hard to eat healthily?”), with an overall mean of 3.92. The mean scores regarding short-term healthy eating intentions ranged from 3.83 (“I want to have a healthy meal in the next 2 weeks.”) to 3.90 (“I would like to recommend healthy meals to my friends, family, and co-workers.”), with an overall mean of 3.85. The mean scores regarding long-term healthy eating intentions ranged from 2.66 (“You will eat at least 8 servings (2 plates) of vegetables/salad daily.”) to 2.91 (“When eating, you will eat a healthy amount (e.g., not eating until you are full).”), with an overall mean of 2.82.

The mean scores regarding attitude during the COVID-19 pandemic ranged from 4.04 (“A healthy diet is generally desirable”) to 4.17 (“A healthy diet is generally good”), with an overall mean of 4.11. The mean scores regarding subjective norms ranged from 3.92 (“Internet information think I should engage in healthy eating.”) to 4.09 (“Family members think I should engage in healthy eating.”), with an overall mean of 3.99. The mean scores regarding PBC ranged from 3.76 (“No matter what the difficulties you have, do you want to eat healthily?”) to 4.05 (“Will you try hard to eat healthily?”), with an overall mean of 3.88. The mean scores regarding short-term healthy eating intentions ranged

from 3.75 (“I have a plan to have a healthy meal in the next 2 weeks.”) to 3.85 (“I would like to recommend healthy meals to my friends, family, and co-workers.”), with an overall mean of 3.80. The mean scores regarding long-term healthy eating intentions ranged from 2.57 (“You will eat at least 8 servings (2 plates) of vegetables/salad daily.”) to 2.88 (“When eating, you will eat a healthy amount (e.g., not eating until you are full).”), with an overall mean of 2.77.

The mean scores regarding attitude at the end of the COVID-19 pandemic ranged from 4.03 (“A healthy diet is generally useful.”) to 4.11 (“A healthy diet is generally beneficial.”), with an overall mean of 4.06. The mean scores regarding subjective norms ranged from 3.90 (“Government agencies think I should engage in healthy eating.”) to 4.02 (“Family members think I should engage in healthy eating.”), with an overall mean of 3.95. The mean scores regarding PBC ranged from 3.88 (“Do you have enough discipline to eat healthily?”) to 4.05 (“Will you try hard to eat healthily?”), with an overall mean of 3.96. The mean scores regarding short-term healthy eating intentions ranged from 3.89 (“I want to have a healthy meal in the next 2 weeks.”) to 3.96 (“I would like to recommend healthy meals to my friends, family, and co-workers.”), with an overall mean of 3.92. The mean scores regarding long-term healthy eating intentions ranged from 2.77 (“You will eat at least 8 servings (2 plates) of vegetables/salad daily.”) to 2.96 (“When eating, you will eat a healthy amount (e.g., not eating until you are full).”), with an overall mean of 2.88.

After adjustment for sex, age, body mass index, current

<Table 2> Scores of components of theory of planned behavior during and after COVID-19

Dependent variables (Cronbach alpha)	Total (n=571)	During COVID-19 (n=305)	After COVID-19 (n=266)	T/p ^{1) 2)}
	Mean±SD			
Attitude (0.960) A healthy diet is generally				
beneficial	4.13±0.83	4.15±0.78	4.11±0.88	0.609
useful	4.09±0.85	4.14±0.77	4.03±0.93	1.609
good	4.11±0.85	4.17±0.76	4.03±0.94	1.875
enjoyable	4.10±0.85	4.11±0.85	4.10±0.87	0.093
interesting	4.05±0.85	4.07±0.81	4.04±0.89	0.440
desirable	4.03±0.83	4.04±0.81	4.03±0.86	0.233
Mean	4.08±0.77	4.11±0.74	4.06±0.80	0.889
Subjective norm (0.951) - think I should engage in healthy eating				
Family members	4.06±0.83	4.09±0.78	4.02±0.88	1.002
My friends	4.04±0.87	4.05±0.85	4.02±0.90	0.415
My schoolmates and co-workers	3.97±0.84	3.98±0.83	3.95±0.86	0.466
Experts	3.97±0.86	3.99±0.82	3.94±0.90	0.653
Government agencies	3.94±0.89	3.98±0.86	3.90±0.93	1.089
TV programs	3.94±0.91	3.95±0.88	3.94±0.94	0.236
Newspapers and magazines	3.95±0.85	3.96±0.86	3.94±0.84	0.338
Internet information	3.92±0.89	3.92±0.87	3.91±0.90	0.199
Mean	3.97±0.75	3.99±0.753	3.95±0.745	0.634
Perceived behavioral control (0.913)				
Will you try hard to eat healthily?	4.05±0.78	4.05±0.78	4.05±0.79	-0.045
Do you have enough discipline to eat healthily?	3.96±0.88	3.93±0.87	3.99±0.88	-0.738
Do you have enough time to eat healthily?	3.82±0.95	3.77±0.94	3.88±0.95	-1.324
No matter what the difficulties you have, do you want to eat healthily?	3.84±0.92	3.76±0.94	3.93±0.89	-2.237*
Mean	3.92±0.79	3.88±0.79	3.96±0.78	-1.267
Short-term behavioral intention (0.948)				
I am willing to have a healthy meal within the next 2 weeks.	3.84±0.92	3.79±0.93	3.90±0.90	-1.316
I want to have a healthy meal in the next 2 weeks.	3.83±0.92	3.79±0.94	3.89±0.91	-1.294
I have a plan to have a healthy meal in the next 2 weeks.	3.83±0.94	3.75±0.95	3.91±0.91	-1.987*
I would like to recommend healthy meals to my friends, family, and co-workers.	3.90±0.89	3.85±0.90	3.96±0.89	-1.373
Mean	3.85±0.85	3.80±0.87	3.92±0.83	-1.611
Long-term behavioral intention (0.900)				
You will eat fruit at least 2 times daily.	2.87±0.75	2.83±0.73	2.91±0.76	-1.344
You will eat at least 8 servings (2 plates) of vegetables/salad daily.	2.66±0.81	2.57±0.79	2.77±0.83	-2.944** (**)
Whenever you choose food, you will choose low-fat foods and drinks.	2.80±0.77	2.76±0.73	2.84±0.81	-1.262
Each time you choose food, you'll choose drinks and foods with less added sugar.	2.85±0.75	2.81±0.73	2.90±0.77	-1.360
When eating, you will eat a healthy amount (e.g., not eating until you are full).	2.91±0.72	2.88±0.70	2.96±0.74	-1.381
Mean	2.82±0.64	2.77±0.62	2.88±0.66	-1.987*

¹⁾*p< .05, **p< .01, ***p< .001

²⁾After conducting a t-test, a multiple linear regression analysis was performed to ensure the robustness of the findings. P-values obtained after adjusting for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment (*p< .05, **p< .01, ***p< .001).

alcohol drinker, current smokers, having disease, marital status, education, and employment, scores of three subcomponents of “No matter what the difficulties you have, do you want to eat healthily?” in the PBC ($p=0.026$), “I have a plan to have a healthy meal in the next 2 weeks” in the short-term healthy eating intention section ($p=0.047$), and “You will eat at least 8 servings (2 plates) of vegetables/salad daily.” in the long-term healthy eating intentions section ($p=0.003$) were greater after the COVID-19 pandemic. Additionally, the overall mean of the long-term healthy eating intentions section ($p=0.047$) had increased after the pandemic.

3. Scores of components of individual and environmental factors related to healthy eating during and after COVID-19

The total mean scores regarding healthy eating-out options, and food attributes ranged from 3.37 (“The food of the restaurant I chose on a typical day is low in calories.”) to 3.65 (“The food of the restaurant I chose on a typical day is beneficial to health”), with an overall mean of 3.48 <Table 3>. The mean scores for healthy eating-out options and food quality ranged from 3.70 (“The taste of the food is original.”) to 3.75 (“The taste of the food is satisfying.”), with an overall mean of 3.72. The mean scores regarding social support ranged from 3.40 (“I or my family made a healthy meal for dinner.”) to 3.79 (“There are healthy snacks at home.”), with an overall mean of 3.60. The mean scores regarding motivation (importance) ranged from 3.21 (“A healthy eating can help to regulate weight.”) to 3.34 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 3.28. The mean scores regarding motivation (agreement) ranged from 4.82 (“A healthy eating can help improve concentration.”) to 4.97 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 4.92. The mean scores regarding healthy eating awareness ranged from 7.09 (“How well prepared are you for conducting a healthy eating life?”) to 8.08 (“How important is healthy eating to your life?”) with an overall mean of 7.46.

The mean scores regarding healthy eating-out options (food attributes) ranged from 3.31 (“The food of the restaurant I chose on a typical day is low in calories.”) to 3.66 (“The food of the restaurant I chose on a typical day is beneficial to health.”) with an overall mean of 3.44. The mean scores regarding healthy eating-out options (food quality) ranged from 3.63 (“The nutritional value of food is high.”) to 3.74 (“The taste of the food is satisfying.”), with

an overall mean of 3.69. The mean scores regarding social support ranged from 3.29 (“I or my family made a healthy meal for dinner.”) to 3.81 (“There are healthy snacks at home.”), with an overall mean of 3.55. The mean scores regarding healthy eating awareness ranged from 6.88 (“How prepared are you for healthy cooking?”) to 8.23 (“How important is healthy eating to your life?”), with an overall mean of 7.31. The mean scores regarding motivation (importance) ranged from 3.22 (“A healthy eating can help to regulate weight.”) to 3.37 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 3.30. The mean scores regarding motivation, (agreement) ranged from 4.90 (“A healthy eating can help improve concentration.”) to 5.07 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 5.00.

After of the COVID-19 pandemic, the mean scores of healthy eating-out options (food attributes) ranged from 3.40 (“The food of the restaurant I chose on a typical day is accurately labeled with their country of origin.”) to 3.64 (“The food of the restaurant I chose on a typical day is beneficial to health.”), with an overall mean of 3.52. The mean scores regarding healthy eating-out options (food quality) ranged from 3.71 (“The food is made of fresh ingredients.”) to 3.78 (“The temperature of the food is appropriate.”), with an overall mean of 3.75. The mean scores regarding social support ranged from 3.53 (“I or my family made a healthy meal for dinner.”) to 3.85 (“There are fruits and vegetables fresh and ready to eat at home.”), with an overall mean of 3.67. The mean scores regarding motivation (importance) ranged from 3.20 (“A healthy eating can help to regulate weight.”) to 3.31 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 3.25. The mean scores regarding motivation (agreement) ranged from 4.73 (“A healthy eating can help improve concentration.”) to 4.87 (“A healthy eating can reduce some diseases or disorders.”), with an overall mean of 4.83. The mean scores regarding healthy eating awareness ranged from 7.28 (“How well prepared are you for conducting a healthy eating life?”) to 7.99 (“How important is healthy food preparation to you?”), with an overall mean of 7.64.

An independent-samples t-test was carried out involving healthy eating-out options (food attributes); healthy eating-out options, (food quality); social support; healthy eating awareness; motivation (importance); and motivation (agreement) among Daqing adults during and after the COVID-19 pandemic.

Higher scores were observed after the pandemic adjusting

for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment. These included the food of the restaurant I chose on a typical day is “beneficial to weight control” (p=

0.012) and “low in fat” (p=0.034) in the healthy eating-out options (food attribute) section, “The nutritional value of food is high” (p=0.029) in the healthy eating-out options (food quality) section, and “I or my family made a healthy

<Table 3> Scores of components of individual and environmental factors related to healthy eating during and after COVID-19

Dependent variables (Cronbach alpha)	Total (n=571)	During COVID-19 (n=305)	After COVID-19 (n=266)	T/p ^(1) 2)
	Mean±SD			
Healthy eating-out option, food attribute (0.936) The food of the restaurant I chose on a typical day is ~				
prepared using natural ingredients	3.52±0.96	3.51±0.92	3.52±0.99	-0.139
packaged in an eco-friendlier manner	3.55±0.88	3.53±0.85	3.58±0.90	-0.746
accurately labeled with the country of origin	3.39±1.01	3.38±0.99	3.40±1.02	-0.215
beneficial to health	3.65±0.87	3.66±0.83	3.64±0.91	0.371
beneficial to weight control	3.46±0.91	3.37±0.97	3.56±0.83	-2.508*
low in calories	3.37±0.98	3.31±0.96	3.44±1.00	-1.561
low in fat	3.39±0.98	3.31±0.97	3.49±0.98	-2.127*
Mean	3.48±0.80	3.44±0.80	3.52±0.79	-1.173
Healthy eating-out option, food quality (0.956)				
The taste of the food is satisfying	3.75±0.79	3.74±0.80	3.76±0.78	-0.228
The taste of the food is original	3.70±0.77	3.65±0.79	3.75±0.74	-1.485
The temperature of the food is appropriate	3.75±0.80	3.71±0.78	3.78±0.83	-0.949
The nutritional value of the food is high	3.70±0.75	3.63±0.77	3.77±0.73	-2.185*
The Food is hygienic	3.72±0.79	3.72±0.79	3.73±0.79	-0.220
The food is made of fresh ingredients	3.71±0.83	3.71±0.79	3.71±0.87	-0.135
Mean	3.72±0.72	3.69±0.73	3.75±0.70	-0.935
Social support (0.864)				
There are fruits and vegetables fresh and ready to eat at home	3.75±1.21	3.68±1.24	3.85±1.17	-1.683
There are healthy snacks at home	3.79±1.11	3.81±1.10	3.77±1.12	0.426
I or my family made a healthy meal for dinner	3.40±1.15	3.29±1.17	3.53±1.12	-2.510*
My family helped me eat fruits and vegetables	3.54±1.05	3.46±1.07	3.63±1.02	-1.930
I prepared healthy snacks or meals with my family	3.53±1.04	3.50±1.04	3.56±1.03	-0.670
Mean	3.60±0.90	3.55±0.90	3.67±0.89	-1.599
Motivation, Importance (0.928)A healthy eating can~				
reduce some diseases or disorders	3.34±0.69	3.37±0.65	3.31±0.74	1.079
make your mood happier through your body	3.31±0.69	3.34±0.65	3.27±0.74	1.210
help to regulate weight	3.21±0.73	3.22±0.70	3.20±0.76	0.449
help improve concentration	3.25±0.65	3.26±0.65	3.23±0.66	0.669
energize every day	3.30±0.67	3.33±0.63	3.26±0.70	1.283
Mean	3.28±0.61	3.30±0.57	3.25±0.64	1.059
Motivation, agreement (0.957)A healthy eating can~				
reduce some diseases or disorders	4.97±1.07	5.07±0.94	4.87±1.19	2.249*
make your mood happier through your body	4.94±1.09	5.00±0.98	4.86±1.19	1.525
help to regulate weight	4.96±1.06	5.05±0.94	4.85±1.17	2.257*
help improve concentration	4.82±1.13	4.90±1.06	4.73±1.20	1.749
energize every day	4.91±1.09	4.99±0.99	4.83±1.19	1.788
Mean	4.92±1.00	5.00±0.90	4.83±1.10	2.066*

<Table 3> Scores of components of individual and environmental factors related to healthy eating during and after COVID-19 (continued)

Dependent variables (Cronbach alpha)	Total (n=571)	During COVID-19 (n=305)	After COVID-19 (n=266)	T/p ^{1) 2)}
	Mean±SD			
Healthy eating awareness (0.910)				
How important is healthy eating to your life?	8.08±2.29	8.23±2.23	7.90±2.35	1.704
How confident are you about conducting a healthy eating life?	7.26±2.36	7.03±2.41	7.53±2.27	-2.572*
How well prepared are you for conducting a healthy eating life?	7.09±2.46	6.93±2.49	7.28±2.40	-1.721
How important is healthy food preparation to you?	7.88±2.30	7.80±2.29	7.99±2.30	-1.013
How confident are you in preparing healthy food?	7.27±2.45	6.97±2.54	7.60±2.31	-3.073**
How prepared are you for healthy cooking?	7.19±2.42	6.88±2.56	7.55±2.20	-3.313**
Mean	7.46±1.98	7.31±2.01	7.64±1.93	-2.038*

¹⁾*p< .05, **p< .01, ***p< .001

²⁾After conducting a t-test, a multiple linear regression analysis was performed to ensure the robustness of the findings. P-values obtained after adjusting for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment (*p< .05, **p< .01, ***p< .001).

<Table 4> Relationship between COVID-19 and healthy eating behaviors

Dependent variables	Reference=During COVID-19			T/p ¹⁾
	B	SE	Beta	
Attitude	-0.216	0.410	-0.023	-0.526
Subjective norm	-0.233	0.542	-0.019	-0.431
Perceived behavioral control	0.278	0.284	0.044	0.979
Short-term behavioral intention	0.438	0.309	0.064	1.419
Long-term behavioral intention	0.526	0.288	0.082	1.828
Healthy eating-out option, food attribute	0.537	0.494	0.048	1.087
Healthy eating-out option, food quality	0.348	0.379	0.041	0.919
Social support	0.020	0.366	0.002	0.055
Healthy eating awareness	0.383	1.049	0.016	0.365
Motivation, importance	-0.376	0.266	-0.062	-1.412
Motivation, agreement	-0.945	0.428	-0.094	-2.208*

¹⁾P-values obtained after adjusting for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment (*p< .05, **p< .01, ***p< .001).

meal for dinner” in the social support section (p=0.012). The mean score (p=0.042) as well as subcomponent scores (“How confident are you about conducting a healthy eating life?” (p=0.010), “How confident are you in preparing healthy food?” (p=0.002) and “How prepared are you for healthy cooking?” (p=0.001)) for healthy eating awareness were greater after the COVID-19.

However, mean scores (p=0.039) and subcomponents (“A healthy eating can reduce some diseases or disorders.” (p=0.025) and “A healthy eating can help to regulate weight.” (p=0.024)) of motivation (agreement) were lower after the pandemic.

4. Relationship between COVID-19 and healthy eating behaviors

Multiple linear regression analyses adjusted for sex, age, body mass index, current alcohol drinkers, current smokers, having disease, marital status, education, and employment showed that only motivation (agreement) for healthy eating decreased after the COVID-19 among adults in Daqing during and after the pandemic (p=0.028) <Table 4>.

5. Discussion

This study used an online survey to compare adults living in Daqing, China, during and after the COVID-19 pandemic,

with a primary focus on differences regarding the TPB and individual and environmental factors related to healthy eating of the residents in the Daqing area between two points in time. Studying the Theory of Planned Behavior (TPB) alongside individual and environmental factors related to healthy eating serves the purpose of exploring the comprehensive influences on individual dietary behaviors. TPB focuses on internal factors within individuals, such as attitudes, subjective norms, and perceived behavioral control, while individual and environmental factors concern the impact of external environments and individual attributes on healthy eating behaviors (Ajzen 1991).

TPB, concentrating on internal factors, encompasses attitudes towards healthy eating, others' perceptions of an individual's healthy eating behaviors, and the individual's perceived control over healthy eating behavior (Wu et al. 2009; Grønhøj et al. 2012). These factors significantly influence whether individuals adopt healthy eating behaviors. On the other hand, individual and environmental factors related to healthy eating highlight the influence of personal and external environmental factors on individual behavior, such as social support, healthy eating-out options, and motivation (Achtziger et al. 2008; Jun et al. 2014; Lee et al. 2020; De Kervenoae et al. 2021). In the context of healthy eating, these factors provide information on individuals' attributes and the healthy eating choices available in their environment, societal cues for healthy eating, and other factors that may influence individual dietary behaviors.

This comprehensive approach enables a thorough understanding of the factors underlying individual healthy eating behaviors, including internal attitudes and beliefs, motivational factors, and the influence of external environments. Such understanding facilitates the development of more effective intervention measures to promote healthier dietary behaviors among individuals. Notably, the distinction between behavioral intention and motivation requires further elucidation. Behavioral intention typically serves as a precursor to actual actions, representing individuals' plans or intentions for action. Motivation, on the other hand, refers to the incentive goals preceding actions, serving as the intrinsic or extrinsic drives that prompt individuals to act on their plans (Ajzen & Kruglanski 2019).

Before conducting comparative analysis, we have taken steps to ensure that both groups under study consist of Daqing Oilfield workers and their family members, with similar attributes. Additionally, we have endeavored to control for other potential confounding variables that could

influence the research outcomes, such as sex, age, BMI, current alcohol drinkers, current smokers, having disease, marital status, education, and employment. After controlling for potential confounders, the scores of several subcomponents of the TPB constructs (perceived behavioral control and short- and long-term behavioral intentions) and the overall mean scores of long-term behavioral intentions increased after the COVID-19 pandemic. Similarly, scores of several subcomponents of healthy eating options, social support, and healthy eating awareness increased after the pandemic. However, the scores of subcomponents and overall mean of motivation (agreement) was found to have decreased after the outbreak. Multiple linear regression revealed that motivation for healthy eating decreased after the COVID-19 pandemic, after adjusting for sex, age, BMI, alcohol drinking experience during the past year, smoking experience, disease history, marital status, educational background, and responsibility of living expenses.

Our study's findings are consistent with previous reports. Compared to the period when the pandemic occurred, individuals' overall food intake decreased after the after of the pandemic (Jehi et al. 2023). Furthermore, after the pandemic ended, people paid more attention to eating healthy foods such as grains, dairy products, and vegetables (Zhou et al. 2024; Žurek & Rudy 2024). Individuals became more concerned about health, as a healthy body can better cope with potential health risks, including the risk of contracting a virus. With the increasing emphasis on a healthy lifestyle, for many, this included changing their eating habits (Yaseen 2021). This can help explain why the respondents were more cognizant of healthy eating after the pandemic.

Studies highlight that after the conclusion of the pandemic, consumers' dietary habits and awareness of healthy eating have gradually shifted toward the pursuit of safer and healthier food options (Qi et al. 2023). This is consistent with the findings of our study, wherein the scores of several subcomponents of healthy eating options, social support, and healthy eating awareness increased after the pandemic. Notably, we observed increases in the values of all of the factors described above. Daqing is a typical immigrant city, where people from all over China gather to engage in oil exploration and development, creating a diverse city formed by immigrant populations (Xue 2020; Yang 2020). Most residents in Daqing are engaged in oilfield occupations or are related to the oilfield workers, so it is a relatively affluent city with a low economic burden. This relatively relaxed economic situation allows Daqing residents to place greater focus on

making healthy dietary choices, a trend that was also clearly reflected in our previous study (Ma et al. 2023). Beginning with the outbreak of the COVID-19 pandemic, its negative consequences have been continuously brought to light, and public has been continually reminded to pay greater attention to their health (Koichi et al. 2020). The government also encouraged people to maintain a healthy and reasonable dietary composition during the pandemic, prompting Daqing residents to further recognize that maintaining good health is related to not only the quality of life of an individual alone but also one's ability to cope with potential health risks (Ying et al. 2020). Considering these factors, Daqing residents were able to clearly recognize the importance of healthy eating due to a combination of their unique social background and the health-related deliberations triggered in everyone by the pandemic.

However, we also observed some inconsistencies in our results. The scores of motivation (agreement) were lower after the after of the COVID-19 pandemic, and multiple linear regression revealed that only motivation for healthy eating decreased after the COVID-19 pandemic, which is inconsistent with our aforementioned results. However, consistent with previous research findings, motivation is typically referred to as the means to achieve a goal (Ajzen & Kruglanski 2019). As demonstrated by obese adults in the UK, during the pandemic, they increased their health-related behaviors, aiming to lose weight by purchasing healthier foods and engaging in physical activities (Brown et al. 2023). This was also reflected in the French population, where the average caloric intake during the pandemic was 1,935 kcal/day, whereas the average intake during non-pandemic times was only 1,700 kcal/day (Marty et al. 2021). Due to the particular nature of the Daqing oilfield industry, where most of the work is conducted outdoors, employees were unable to work remotely (Cheng 2006). Therefore, for the employees of the Daqing oilfield and their families, quarantine at home was necessary only during the pandemic, which provided them ample amount of free time. Additionally, it is reported that during this period, approximately 149 million deaths attributed to COVID-19 were recorded (Taylor 2022). As such, during the pandemic, adults in Daqing were more inclined to prioritize health as a goal and adopt healthy eating practices as a means to achieve a healthy lifestyle. However, this relaxed mindset was ended with the after of the pandemic, and although residents wanted to engage in healthy eating behaviors, the structure of their lives and work accelerated and made this less attainable.

As a result, people may have been more inclined to choose quick and convenient food than to spend additional time and effort planning a healthy diet (Cheng 2006). With the gradual resumption of social activities, people started moving into a state of retaliatory consumption (Gupta et al. 2022; Taylor 2022; Gao et al. 2023) and were more likely to be influenced by their peers in social situations, including choosing less healthy foods because they were seen as being more popular or more conducive to social activities (Cheng 2006). This could explain the phenomenon of the decrease in motivation (agreement) for healthy eating among the people of Daqing after the pandemic.

There were some limitations to our study. First, due to COVID-19, data were exclusively collected online. Although we provided a detailed description of each question, online collection still necessarily leads to a loss of accuracy relative to the results obtained in face-to-face data collection. Second, we used the snowball sampling method, which resulted in high homogeneity in respondent characteristics. Here, we only explored the differences in factors from the TPB and the individual and environmental factors related to healthy eating among adults in Daqing during and after the pandemic, without delving into the reasons for these differences. Lastly, it's important to note that this survey solely pertains to the city of Daqing, China, and the surveyed individuals possess highly similar attributes. Therefore, the findings from this single-city study may not be representative of the entire population of China. To validate the generalizability of this research, future studies will aim to incorporate comparative analyses across various regions. By doing so, we can gain a more comprehensive understanding of the differences and commonalities among different areas, thus enhancing the credibility and applicability of the research findings. However, our study also had several strengths. Firstly, it enabled an understanding of the evolution in the intentions of Daqing residents toward engaging in healthy eating. Second, we addressed questions related to environmental investigations into an original study. Finally, this it helped fill a gap in the understanding from previous related studies (Ma et al. 2023). It is worth noting that Daqing's unique qualities make it quite unlike other municipalities in China and thus worth studying on its own terms. Our study has several limitations. Firstly, the two surveys were not conducted with the same group of individuals, encompassing a total of 571 people, of whom 53.4% were surveyed during the mid-pandemic period. Additionally, there were differences in the general characteristics of the study subjects, such as the number of males, BMI,

current alcohol drinkers, those with a bachelor degree or above, and living expenses paid by employed which had lower averages or percentages in the subjects post-pandemic compared to during the pandemic. Conversely, characteristics such as age, current smokers, having disease and marital status had higher averages or percentages in subjects after the pandemic compared to during. However, we adjusted for these differences in our statistical analysis. Secondly, due to COVID-19, all data were collected online. Although we provided detailed descriptions for each question, online collection inevitably led to a decrease in accuracy compared to face-to-face data collection. We used a snowball sampling method, resulting in a high homogeneity of response characteristics. Here, we only explored the differences in factors related to TPB (Theory of Planned Behavior) and individual and environmental factors related to healthy eating among adults in Daqing during and after the pandemic, without delving into the reasons for these differences. However, our study also has several strengths. Firstly, it provides insight into the evolution of intentions to engage in healthy eating among Daqing residents. Secondly, we incorporated questions related to individual and environmental factors related to healthy eating into the original study. Finally, it helps to fill the gaps in understanding from previous related studies [9]. It is noteworthy that Daqing's unique qualities make it distinctly different from other cities in China, thereby warranting its own study.

IV. Summary and Conclusion

The majority of Daqing residents are employed in the oil industry or are family members of oilfield workers. The government also encouraged people to maintain healthy dietary components during the pandemic, prompting residents of Daqing to recognize that maintaining good health is related not only to the quality of individual life but also to the individual's capacity to cope with health risks. However, with the after of the COVID-19 pandemic, as social activities gradually reopened and the pace of life and work structures accelerated, people began to favor fast and convenient food options over spending extra time to plan healthy diets. Compared to during the pandemic, people's priorities shifted from eating healthily to focusing more on speed and convenience. Consequently, post-pandemic, people are less willing to invest additional time and effort in planning a healthy diet, which is a primary reason for the decline in motivation for healthy eating.

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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